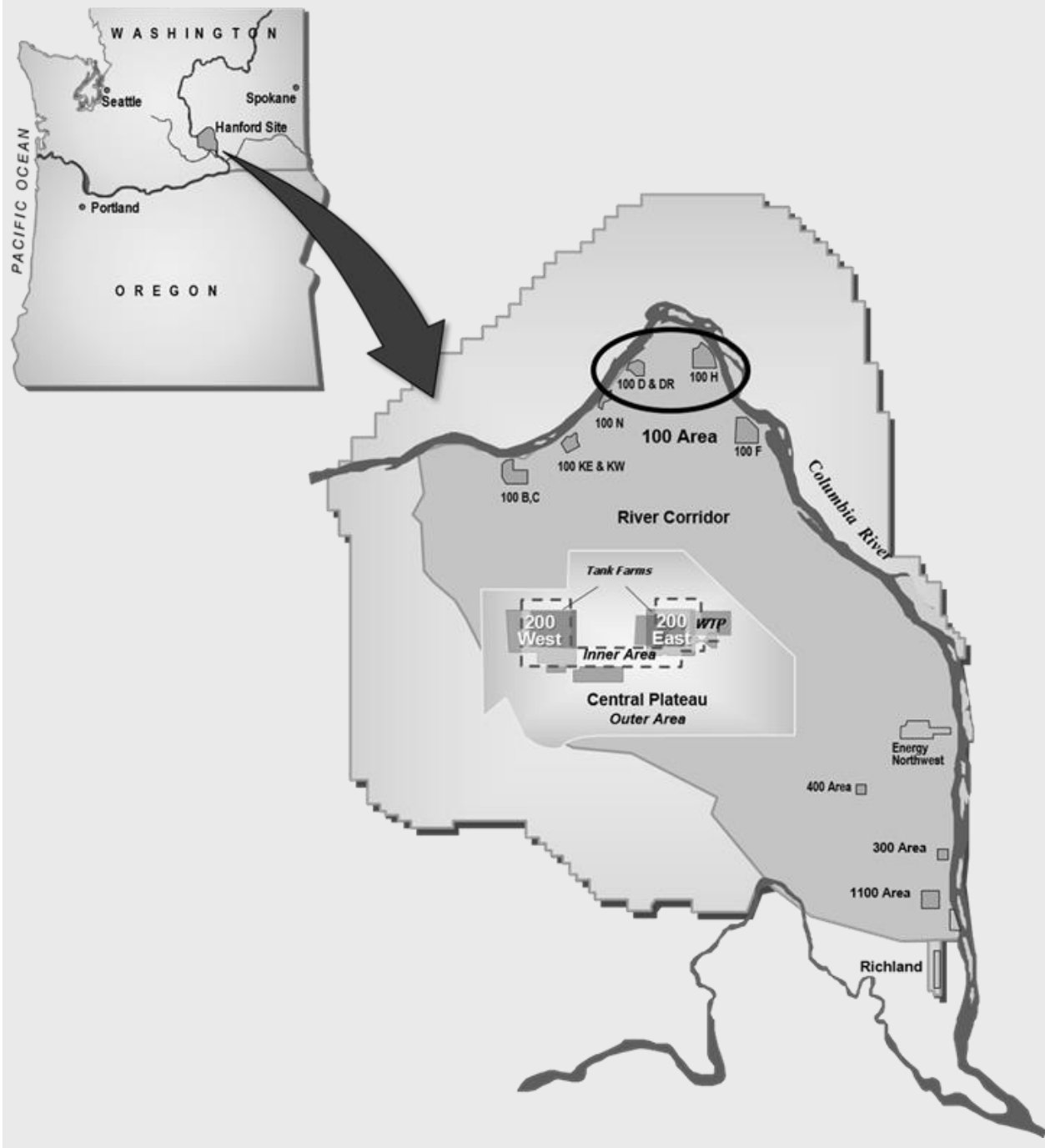


100-D/H Area Proposed Plan – Questions and Answers



100-D/H is one of six Hanford Nuclear Reservation cleanup areas along the Columbia River in Washington State. Past reactor and production operations resulted in soil and groundwater contamination. ~~There will be approximately 300 waste sites addressed in the final Record of Decision.~~ The ~~United States (US) Tri-Party Agencies, US~~ Environmental Protection Agency (EPA), ~~US Dept. of Energy (USDOE) and WA State Dept. of Ecology (Ecology)~~ ~~are is~~ preparing a final Record of Decision (ROD), a public document explaining the remediation plan for the site. There will be about 300 waste sites addressed in this final ROD.

Q: Give an overview from Hanford's Nuclear Legacy.

A: The Hanford Nuclear Site in southeastern Washington State was home to plutonium production for our nation's nuclear stockpile. The race to build the atomic bomb and win World War II and the Cold War unfortunately created what many consider to be the most polluted spot in the western hemisphere.

The site is located along the banks of the Columbia River. It is where the nine former plutonium production reactors (B Reactor, C Reactor, D Reactor, DR Reactor, F Reactor, H Reactor, K-East Reactor, K-West Reactor, and N Reactor) were built from 1943 through 1965. They were constructed next to the river because of the abundance of hydroelectric power and cooling water needed by the reactors during operation.

These reactors were needed to facilitate the process by which the element uranium was changed into the man-made element plutonium. Plutonium, known as an isotope, was the critical substance required in order for atomic weapons to be produced. In order to understand how the uranium was changed into plutonium, a basic understanding of chemistry is needed.

Chemistry Overview of Plutonium Production

In the universe, atoms combine to form all solids, liquids, and gases. Within each atom, there are particles called neutrons, protons, and electrons. The number of each of those particles determines the material that you have. For example, if you are looking at a material where there are 92 protons and 146 neutrons, you are looking at a material called uranium 238 (adding together the protons and neutrons gives you the number 238).

Inside the nuclear reactors at Hanford, a process called a chain reaction changed the chemical composition of uranium by exposing the material to extra neutrons. During Hanford's mission of plutonium production from 1943 through 1987, tons of plutonium were produced as a result of hundreds of thousands of tons of metal uranium fuel rods being subjected to the nuclear chain reactions in the reactors.

This process of producing plutonium is extremely inefficient. The years of plutonium production generated millions of tons of solid waste and contaminated soil, as well as billions of gallons of liquid waste. Cleaning up those wastes constitutes Hanford's current mission for the Department of Energy (DOE).

Q: Give some historic details about the reactor areas addressed in the 100 D/H Proposed Plan.

A:

D and DR Reactors

The world's second full-scale nuclear reactor was the D Reactor at Hanford. ~~It which~~ was built in

the early 1940's and ~~went operational~~ began operating in December ~~of~~ 1944. ~~D Reactor ran through June of 1967, and was ultimately cocooned in 2004.~~ **Explain cocooning of reactors**

D Reactor is unique in a couple of ways. First, the reactor's Control Room is the property of the Smithsonian Institution in Washington, D.C. and has occasionally been part of an exhibit and placed on display at the museum. Second, the D Reactor's early days of operation weren't as smooth as operators would have liked.

It appears that in the late 1940's, after the D Reactor had only been operational for a few years, scientists detected a problem with the reactor operations. They were so concerned that D would fail that they built another reactor, called the DR Reactor, right next door. ~~Second, the D Reactor's early days of operation weren't as smooth as operators would have liked.~~ By October of 1950, DR (which stands for D-Replacement) Reactor went on line as the fifth plutonium production reactor at Hanford.

At about the same time, the problems associated with the D Reactor were solved, and both D and DR Reactors ~~ran side-by-side~~ operated into the mid-1960's ~~when they were shut down.~~ ~~Since then, both reactors have been cocooned (DR in 2002, D in 2004).~~

D Reactor was one of the Site's longest serving facilities with 22 years of service, ~~while~~ DR was only operated for ~~the reactor that was on line for the shortest amount of time,~~ 14 years.

DR was ~~Since then, both reactors have been cocooned in 2002, and D in 2004. (DR in 2002, D in 2004).~~ In the cocooning process all external electrical, pipelines, smokestacks and other support facilities are demolished and removed. A concrete shell is then built around the remaining structure.)

H Reactor

The H Reactor, ~~the fourth reactor was the first reactor to be built~~ at Hanford, was built after World War II as the Cold War was starting. It ~~became~~ began operational in October of 1949, ~~and represented the fourth nuclear reactor on the Site.~~

~~H Reactor was built as tensions grew between the US and Russia, ultimately leading in to the Cold War.~~ With the continued strain on relations between the US and Russia ~~two superpowers,~~ H ~~Reactor~~ was followed by DR, C, K-West, and K-East Reactors. ~~all~~ All were being built within a five and a half year ~~periods~~.

~~H Reactor, located between the D and the F Reactors, H at Hanford, operated for 15 years.~~ It was shut down in April of 1965. In 2005, H Reactor became the fifth reactor on the Site to be cocooned.

Q: Where did the contaminants in the groundwater and soil come from?

A: Liquid and solid wastes discharged during the reactor operational periods were the primary contaminant sources in the reactor areas. The majority of the contaminants from the liquid waste stream were the result of pinhole leaks in the fuel cladding. When a pinhole occurred,

contaminants were released to the cooling water and then were diverted to cribs and trenches. Other ~~C~~contaminant sources in the 100 Areas included: ~~cooling water facilities,~~ underground piping, liquid and solid waste disposal sites, and unplanned releases.

Groundwater contaminants in the 100-D/H Area include:

Hexavalent chromium —used for anti-corrosion. It is recognized as a human carcinogen.

Nitrate — an oxidizing agent, nitrate salts are found naturally on earth as large deposits.

Strontium-90 – a radioactive isotope of strontium produced by nuclear fission with a half-life of 28.8 years.

Q: How has contamination spread in the environment ~~and why are the contaminants being cleaned up? (ie. Why are they bad?) Harm to fish, etc.~~

Explain primary reason for these efforts: aquatic species, not humans?

Some of the contaminants aren't very mobile, and released to the soil exhibit low mobility~~move slowly through the soil~~ and are found primarily near the disposal sites. More mobile contaminants move relatively freely through soil and have spread beyond disposal areas. Depending on how much water was involved, even low mobility materials may have been pushed deeper into the ground. **Simplify/explain mobility**

~~Low mobility contaminants, including many metals and radionuclides, were found at the greatest concentrations within and near the areas of discharge. When little or no liquid effluent was discharged to a waste site, soil contamination remained in the shallow sediment. Disposal of high volumes of contaminated liquid waste resulted in dispersion of low mobility contaminants deeper in the ground in comparison to low volume liquid discharge sites.~~

Mobile and moderately mobile contaminants common to the 100-D/H Area include, nitrate and hexavalent chromium. Sodium dichromate, which was the source of the hexavalent chromium (Cr-VI), was added to reactor cooling water as an anti-corrosion agent. Large volumes of water containing hexavalent chromium were discharged to the soil via trenches, cribs, and leaks from pipelines and retention basins. Cooling water was also released through outfall piping to the Columbia River. ~~Large groundwater built up mounds developed~~ beneath high-volume surface discharge sites and increased the spread of contaminants in groundwater during operations.

Historical process information suggests that small volumes of high-concentration solutions of sodium dichromate leaked or spilled in the 100 Areas (for example, during the transfer of sodium dichromate from rail cars to storage tanks). At some locations in the 100-D Area, concentrations of hexavalent chromium in groundwater exceeded the concentrations found in reactor cooling water, indicating a high-concentration source. Chromium could threaten the health of aquatic species, and the groundwater flows to the Columbia River. Our primary focus is to prevent further spread of Cr-VI.

Remedial actions have included excavation of contaminated soil. Some of these excavations have extended to groundwater. There are very few (8-10) waste sites remaining in 100 D/H.

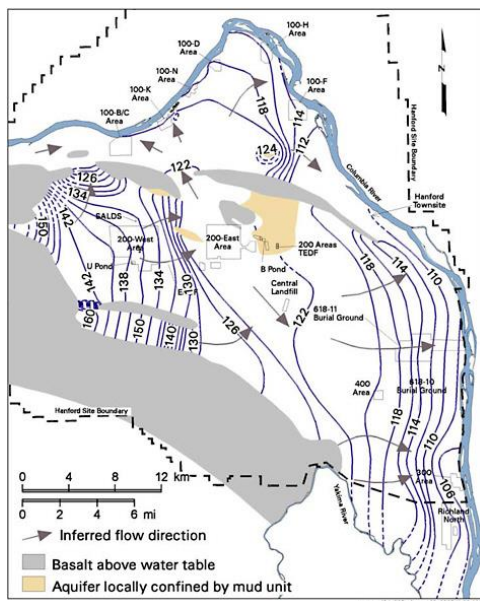
Explain how #1 way contamination is brought to the surface is ants

Get more specific for DH — (example there are ___ # of wells, etc)

Q: How is the contamination spread being monitored?

A: Hanford is one of the most heavily monitored sites in the world. An extensive environmental monitoring program has existed for decades. Each year, monitoring staff collect thousands of environmental samples both onsite and within a 50-mile radius of the Hanford Site. There are 50 air sampling stations located onsite and as far away as Walla Walla, Yakima, Moses Lake, Mattawa, and McNary Dam.

Samples include: surface water, wildlife, soil, groundwater, foodstuffs, vegetation, and air. Samples are analyzed to detect radionuclides and other site contaminants. Several state and federal agencies also have programs to monitor and confirm the accuracy of the information collected at Hanford.



Q: What is the interconnectivity of the areas with the groundwater?

A: Monitoring is used to track contaminants from source areas, which are typically identified based on waste sites associated with a production process or area. For 100 D/H, the waste sites were divided into the 100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2 source operable units. Contaminants in groundwater from these four source operable units identify the 100-HR-3 groundwater operable unit. Results of groundwater contaminant monitoring at the Hanford Site, including the 100-HR-3 operable unit, are reported annually [in the Hanford Site Groundwater Monitoring Report](#).

Groundwater is connected to the Columbia River. Groundwater in the 100 Area generally flows north/west to the river, while the rest of the site's groundwater generally flows to southeast. Groundwater is influenced by the river as far as half-a-mile from the actual shoreline. Generalize how groundwater is connected to surface water

Q: What cleanup work has been completed in these areas so far? (How do interim cleanup actions work, and explain the interconnectivity of the two areas with the groundwater)?

A: In the early 1990s, DOE, EPA, and Washington State Department of Ecology (Ecology) decided that sufficient information about contaminated soil and groundwater in the Hanford Site River Corridor was available to begin interim remediation with a focus on protecting the Columbia River. This decision led to an early start for cleanup of contaminated soil and groundwater in the River Corridor. Key components of the early cleanup included removing contaminated facilities and soil (waste sites) near the river, and implementing interim cleanup actions.

At the 100 D/H Area, a series of investigations were conducted for waste sites in the source operable units (100-DR-1, 100-DR-2, 100-HR-1, and 100-HR-2) and groundwater in the 100-HR-3 operable unit. The investigations provided an initial characterization of the nature and extent of contamination, identified contaminant concentrations in waste sites that were above human health direct contact risk levels, and determined that hexavalent chromium concentrations in groundwater were above drinking water standards (DWSs) and entering the Columbia River at concentrations considered toxic to aquatic organisms. This led to the selection of interim actions to remediate source and groundwater contamination under interim action Records of Decision, issued by EPA to identify specific response actions. The response actions included removal of contaminant sources (waste sites) and treatment of groundwater to remove contaminants and prevent discharge of contaminants to the Columbia River.

For a majority of the waste sites, cleanup is done by digging up the contaminated soil and safely disposing of it. This approach is known as removal, treatment, and disposal (RTD). Hexavalent chromium groundwater contamination is treated by use of pump and treat (P&T) systems. This approach uses wells to extract contaminated groundwater, a treatment system to remove the contamination, and other wells to inject the treated water back into the groundwater. Other cleanup approaches included installing chemical reaction barriers to bind contaminants, which reduces or stops the contamination reaching the Columbia River.

Q: How does the interim decision-making process work, what interim decisions were made, and when did those decisions go into effect)?

Explain why we had interim decisions in the first place

A: In 1989, DOE, EPA, and the Washington State Department of Ecology (Ecology) signed the *Hanford Federal Facility Agreement and Consent Order*, also known as the Tri-Party Agreement (TPA) to provide a framework for the cleanup of the Hanford Site. The scope of the agreement addressed the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remediation of inactive hazardous waste sites and active waste management, *Resource Conservation and Recovery Act of 1976* (RCRA) corrective action for solid waste management units, and closure of RCRA treatment, storage, and disposal (TSD) units across the Hanford Site.

In 1991, the TPA Agencies determined there was a need to prioritize the CERCLA investigations and identify early actions to address waste sites and groundwater contamination. *Hanford Past-Practice Strategy* provided the basis for prioritizing investigations and cleanup actions across the Hanford Site. This strategy emphasized the need to address waste sites and groundwater contamination that may pose a near-term impact to public health and the environment. In addition, the strategy proposed a bias for action to clean up waste sites and existing contamination where the need for a remedy was evident

The first interim action record of decision for 100-D/H was issued in 1995. An interim action addresses more immediate threats until the remedial investigation/feasibility study process needed to make a cleanup decision with a permanent remedy can be performed. A final decision follows the interim decision.

Remediation and characterization of the waste sites in 100 D and 100 H began in 1996 under the authority provided by the interim action RODs and RCRA closure plans, and continues to the present. Remediation consists mainly of (1) RTD of contaminated soil, debris, and waste material; and (2) verification sampling and computer modeling (as needed) to determine whether direct exposure and groundwater protection cleanup requirements have been achieved. After remediation, the excavations are backfilled with approved material, and native shrub steppe flora (plants that are native to the land) are planted.

The TPA Agencies decided all groundwater would be cleaned up under the CERCLA remedial action process that included the 100-HR-3 OU. Groundwater cleanup at 100-HR-3 was initiated following the 1996 interim action ROD that identified P&T as the remedial action.

Q: Where is the waste going?

A: Explain transport of waste to ERDF.

To clean up chromium contamination in the 100-D Area, DOE recently completed two excavations to a depth of 85 feet, removing 2,544,464 tons of contaminated material that was taken to the landfill at Hanford called the Environmental Restoration Disposal Facility (ERDF). Some of this contaminated soil required treatment for stabilization at ERDF prior to being placed in the landfill.

Q: What cleanup work remains that is discussed in this Proposed Plan?

A. The proposed plan addresses cleanup of approximately 300 waste sites.

Q: What future cleanup work remains after the 100 D/H ROD goes into effect, such as reactor dismantlement and restoration, and what is the estimated timeframe?

Provide info: NEPA decision to dismantle reactors has been made

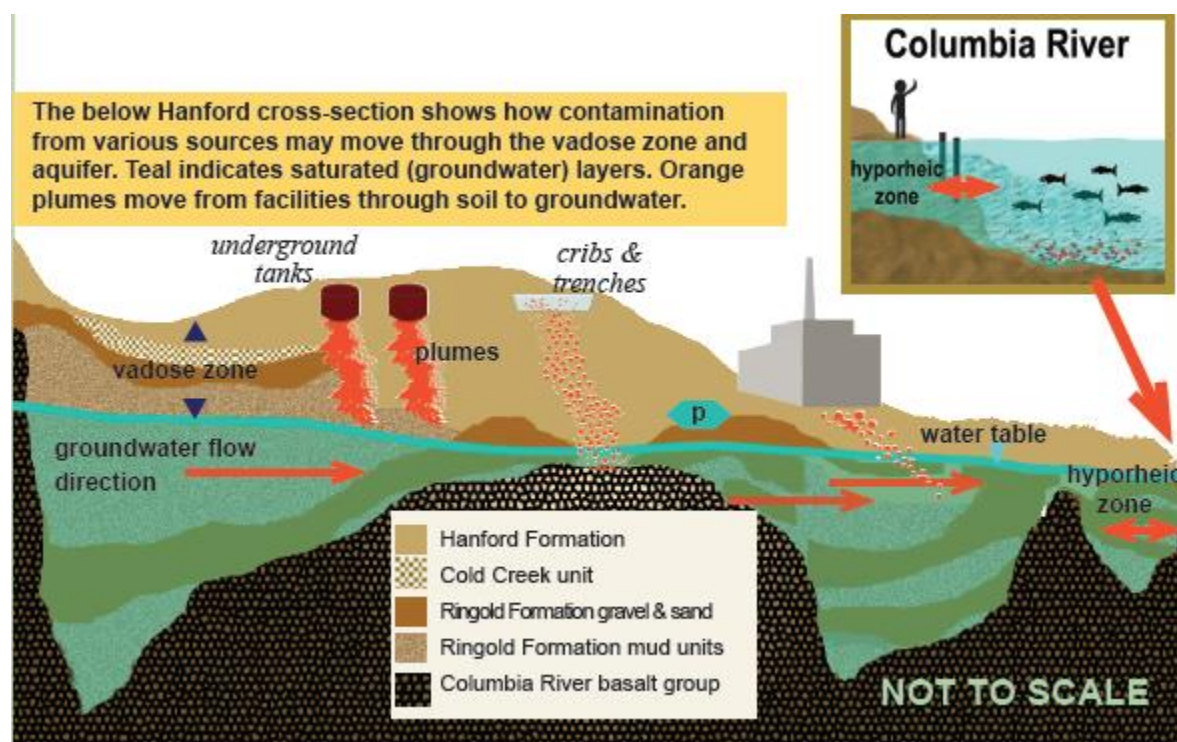
Expand on the process of the pump and treat system

A: The 100 D/H Proposed Plan identifies the preferred alternative and remedial actions that will be completed under this alternative. The remedial actions include RTD and monitored natural attenuation with institutional controls for waste sites, and increased capacity pump and treat and monitored natural attenuation for groundwater. There are 106 waste sites identified for RTD and 37 for monitored natural attenuation with institutional controls.

Explain the 5-10 that need further evaluation. Because final cleanup levels have gone down, still waiting for this information from the language in the proposed plan. One other waste site includes a maternal bat colony. The associated pipeline in the underground tunnel is proposed for end capping and an institutional control for entry restriction. The estimated time to achieve waste site cleanup is 25 years. The proposed plan identifies increased capacity P&T and monitored natural attenuation for groundwater cleanup. The estimated times to achieve cleanup requirements are 12 years for hexavalent chromium, six years for nitrate, and 44 years for strontium-90.

The 100 D/H ROD goes into effect when issued by EPA. The ROD will identify the cleanup work remaining under CERCLA for the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, and 100-HR-3 operable units. There is not a definite timeframe that has been determined for dismantlement of the reactors that have been cocooned. The assumption is that about 75 years is needed for the reactors' radioactivity to decay to levels low enough to allow dismantlement.

Explain what will remain once this work is complete, what is left standing/operating? Pump and treat, well monitoring, etc



Section to explain general groundwater and cleanup concepts

The diagram above depicts a visual representation of most of the terms used to describe groundwater and its properties and behaviors.

Groundwater is the general term used for water saturating the interconnected cracks or pores between rocks or grains of sand below ground, while **aquifers** are usually named geologic units where groundwater is present.

Water table is the term used to reference the top of the saturated zone in an aquifer.

The **vadose zone** is the area between the ground surface and the top of the water table.

Confined aquifers are areas where the aquifer is contained between impervious (solid) layers, while **unconfined aquifers** are where groundwater moves through saturated layers in the ground, slowly working its way in or out of the earth.

An **aquitard** is a non-permeable area that groundwater travels around but not through. Features like clastic dikes (a vertical clay formation) can cause groundwater flow to change direction.

Perched water is water that was somehow trapped in an area separate from the main aquifers in a geologic unit
(-in diagram.)

Plume (like a plume of smoke) is the term used to describe a trail of pollution spread underground. The shape of a plume is estimated by plotting out where contamination is detected in a set of wells.

Groundwater may **recharge** from the surface or underground from nearby rivers, lakes, or streams. Groundwater may recharge quickly or slowly.

A **hyporheic zone** is an area where the river influences groundwater and water moves freely between the stream channel and soils.

The geologic make-up of an area determines whether groundwater surfaces through springs, flows laterally into nearby water bodies, or sinks deeper into the earth. If too much water is pumped from wells, natural precipitation or surface water may not be able to recharge an aquifer. The water table in central Hanford is about 200 feet below ground surface, while along the rivershore, water moves freely between the river and groundwater.